Space Weather Technical Forecast

Issued on Thursday, 27 January 2022 at 01:08 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Slight chance G1/Minor Geomagnetic Storm day 2 (28th) and R1 Radio Blackouts.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been low through the last 24 hours, with a couple of C-class flares, primarily from AR2938 Bxo/Beta in the northeast. This region still has the potential to reveal more complexity as it rotates into a clearer view. AR2936 Dai/Beta has been the most developmental area, with a main leader spot developing and a number of intermediate regions emerging. There are four further regions, including a newly emerged region in the northwest, however these have been generally inactive. The exception was AR2934 Hsx/alpha, which whilst a simple mature alpha spot had a likely filament eruption occur from within it. No CME has been observed from it, however we are still waiting for further imagery. No other Earth-directed CMEs have been observed, however a notable CME was observed in imagery from a far-sided eruption.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 has shown three distinct regions. Initially around 470-480km/s, this then declined to be generally around 420-440 km/s around 26/0900 UTC, and then climbed again to 490-520km/s around 26/1800 UTC. The density was generally near average 6-11ppcc. The total field strength (IMF) Bt, was initially around 6-8nT, but fell to generally 4-6nT from 26/1300 UTC. The north-south component, Bz, remained variable ranging between +6nT and -6nT. Phi angle was generally positive (away from the Sun), but with some brief negative intrusions. These elevated winds were likely due to ongoing fast wind influence from CH46, and whilst weak passing CME influence cannot be ruled out, any signal is too weak to confidently identify. Geomagnetic Activity remain Quiet to Unsettled (Kp 2-3)

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), was at background to moderate levels. The associated electron fluence was below the Active threshold, with 1.77e6 recorded at 27/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to remain Low to Very Low. There are six sunspot regions on the Earth-facing disc, with a slight chance of activity increasing to Moderate, primarily from AR2936 and AR2938, both in the northeast.

Solar Wind / Geomagnetic Activity: There is one CME on the Earth-Sun line that has been assessed, but currently expected to pass over Earth around 29/0000 UTC, although a glancing impact cannot be ruled out. Ongoing fast wind influence of CH46 is expected to decline day 1 (27th) before the arrival of a further fast wind enhancement from CH47 on day 2 (28th). Solar winds are expected to become elevated again, likely around 550km/s, before gradually easing later day 3 and day 4 (29th and 30th). Geomagnetic activity is forecast to Quiet to Unsettled day 1 (28th), increasing to Unsettled to Active with onset of the fast winds of CH47 day 2 (28th) with a slight chance of G1/Minor Storm interval mainly due to any glancing CME impact. Activity then

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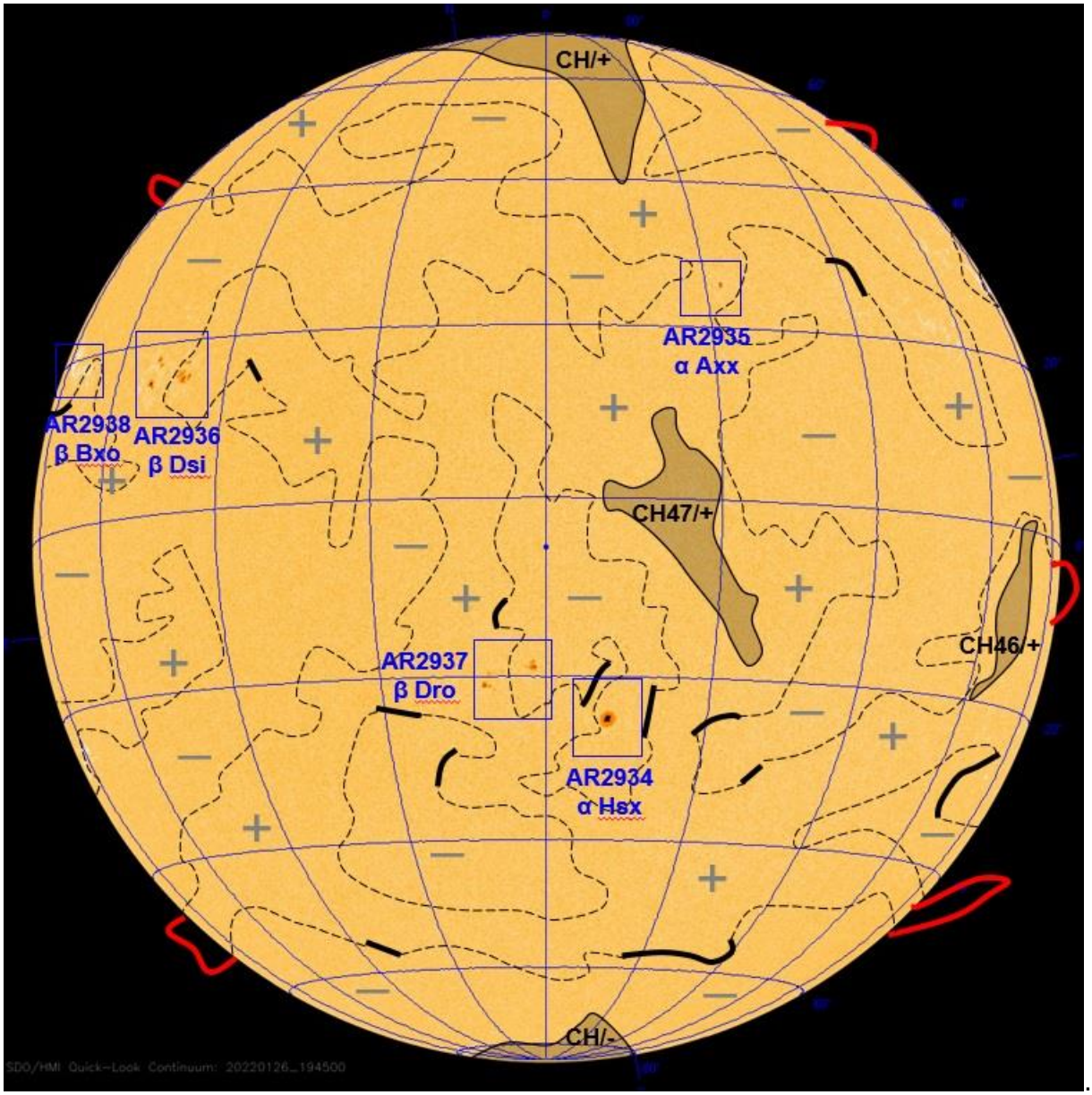
easing to be mainly Quiet to Unsettled by late day 3 and day 4 (29th and 30th).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to remain at background levels. The high energy electron flux (greater than 2MeV) is currently at background levels. There is the potential for this to rise to Moderate, perhaps peaking high levels, perhaps briefly day 1 (28th), but mainly by the end of the period as enhanced winds ease. The associated 24hr fluence has only a slight chance of reaching the Active threshold by the day 4 (30th).

Figure 1. Solar Analysis Valid 27/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There is one CME currently expected to pass near Earth during the forecast period, however the bulk of this CME is forecast to miss passing north of the Earths orbital plane. This was from a filament eruption on the 24th, potentially associated with a C2-flare. This has a slight chance of glancing influence around 29/0000UTC. A filament eruption at 26/1945 UTC, from near AR2934, is likely to be Earth-directed if a CME has been produced. We are awaiting imagery in order to confirm this.

Earth is currently within the fast wind of CH46, and the currently elevated solar winds are expected to ease through day 1 (27th) before the potential arrival of the fast wind of CH47, likely on day 2 (28th). Similar strength winds are possible to the current fast wind enhancement, perhaps peaking around 550 km/s. This is in-line with expectations from persistence, and also timings of an enhancement seen in STEREO A PLASTIC data, although this is contaminated with a CME arrival. Solar winds are expected to ease again day 4 (30th) onward.

Geomagnetic activity is forecast to Quiet to Unsettled day 1 (28th), increasing to Unsettled to Active with onset of the fast winds of CH47 day 2 (28th) with a slight chance of G1/Minor Storm interval mainly due to any glancing CME impact. Activity then easing to be mainly Quiet to Unsettled by late day 3 and day 4 (29th and 30th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	20	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
25/0220	Partial	Filament	N23 E001	376	29/0000 UTC	Likely missing but low chance

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Figure 2: Solar Wind Persistence Model

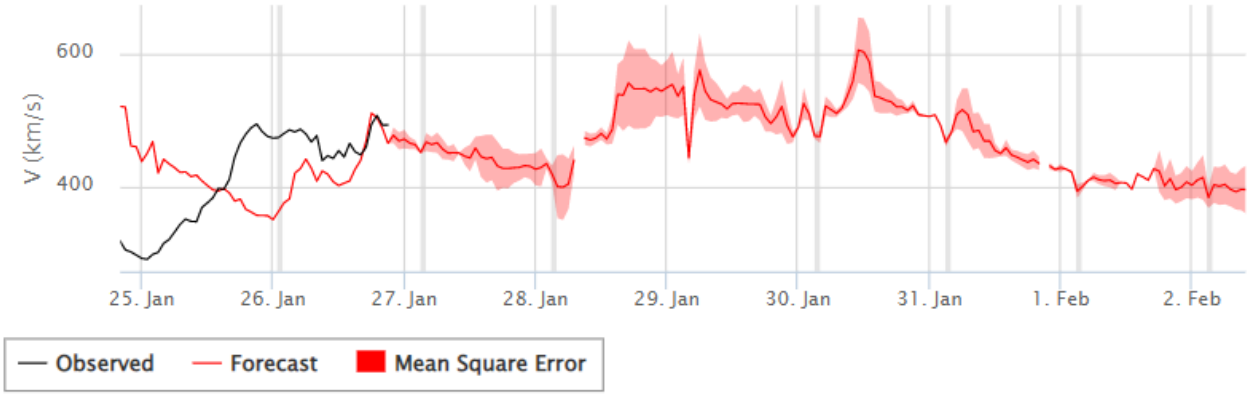
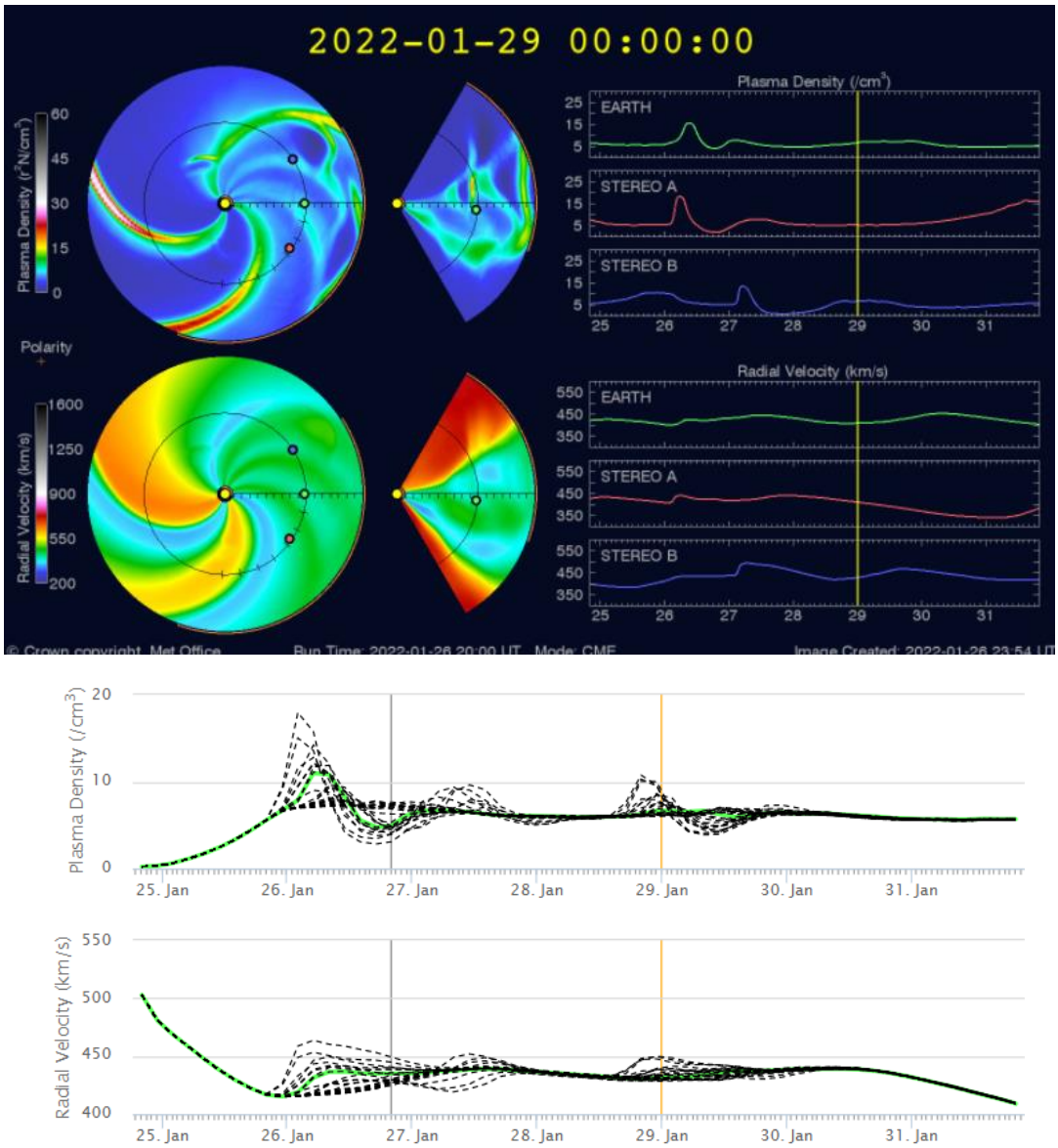


Figure3: Enlil and ensemble showing a slight chance of glance from CME



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Radio Blackouts - X-Ray Flares:

Solar Activity is currently Low, with the main activity from recently numbered regions AR2938 including a C7 flare at 26/0732 UTC. There are six sunspot containing active regions on the Earth-side, along with a couple of plage regions in the northwest and southeast.

AR2938 Bxo/Beta, whilst currently a relatively simple sunspot has emitted a number of C-flares as it has rotated onto the Earth-side, but remains too close to the limb for a confidence analysis. Nearby AR2936 Dai/Beta has been showing signs of development, with a number of small spots developing amongst its surrounding plage. This sunspot has some latitudinal spread, and despite currently fairly magnetically simple, is expected to continue evolving over the coming day. AR2935 Axx/alpha in the northwest has been declining, although a new Bxo/Beta region has also recently emerged from the vicinity of its decayed trailer spot. AR2937 Dro/Beta has remained a fairly inactive region in the southern hemisphere, with spreading of its lead and trailer. AR2934 Hsx/alpha has not shown any development, but there was a recent B5-flare, with a potential filament lift from it.

Solar activity is forecast to remain Low to Very Low, with bit a slight chance (15%) of increasing to Moderate with the potential for M-flares (R1/R2 Radio blackout), with the main risk from AR2936 and AR2938.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	15	15	15	15
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 4: GOES-16/17 X-ray Flux

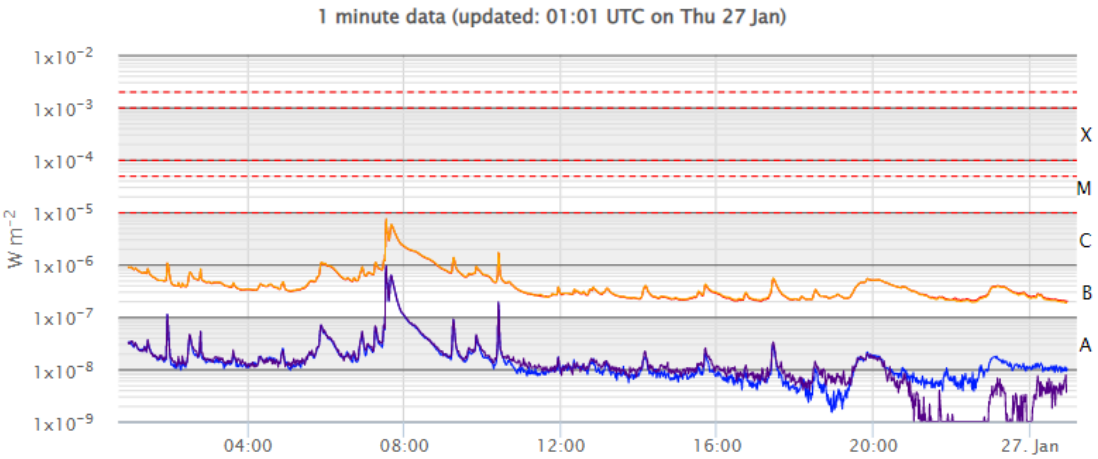

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Figure 5: SDO Intensitygram (left) and Magnetogram (right) of AR2938 and AR2936

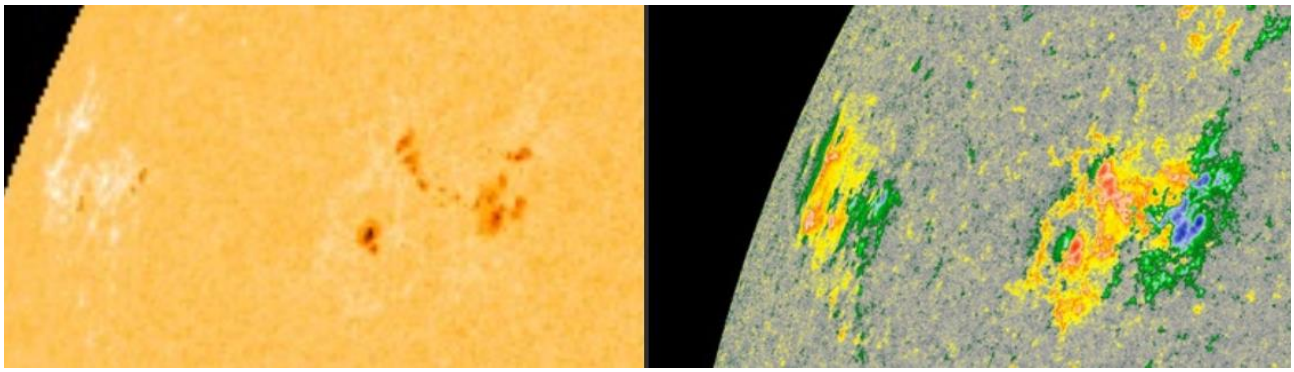
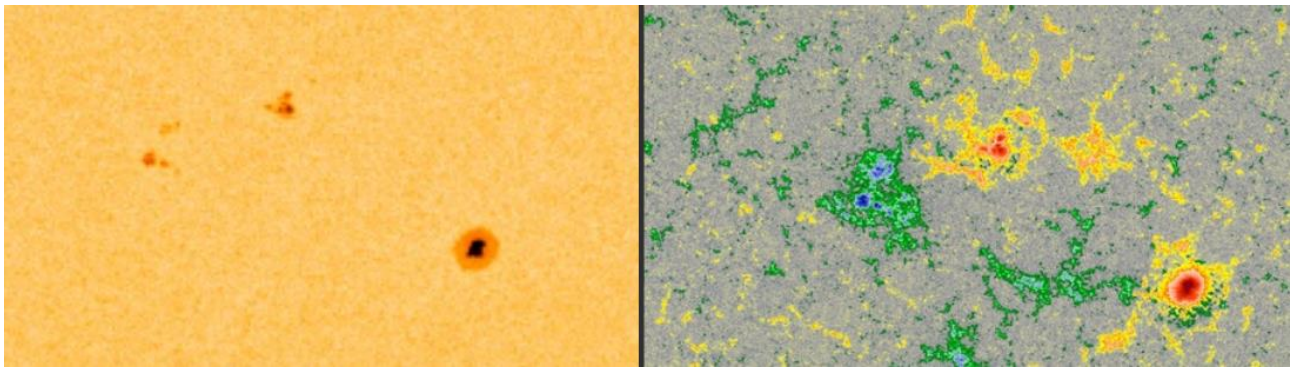


Figure 6: SDO Intensitygram (left) and Magnetogram (right) of AR2937 and AR2934



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are expected in the period.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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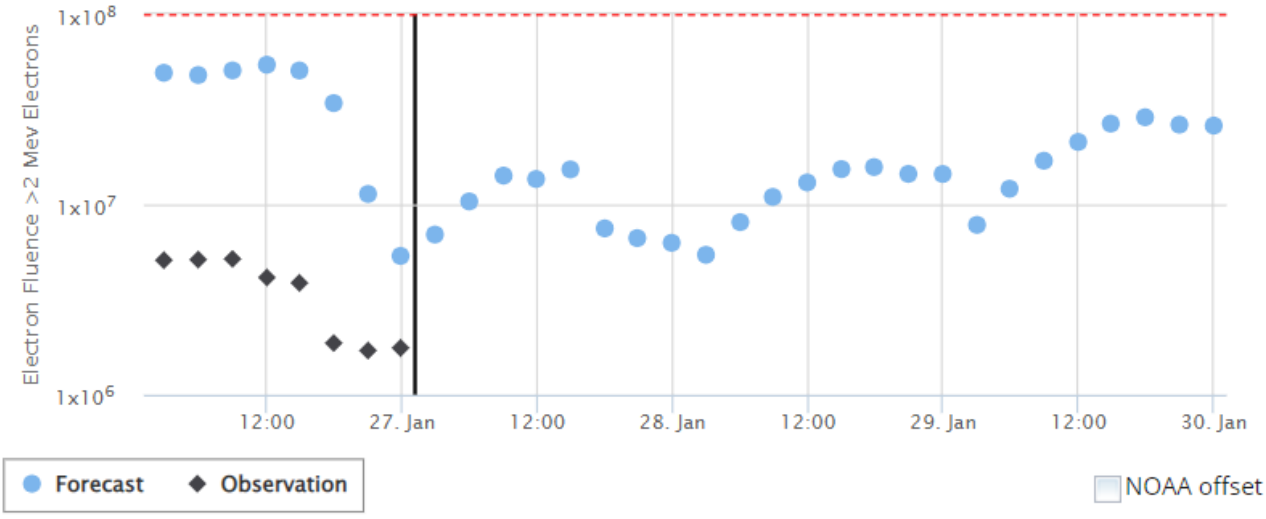
High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 at GEO is currently at background. This has the potential to rise as solar winds ease day 1 (28th), but is likely to be suppressed again by the onset the fast wind of CH47 day 2. Given the limited strength from either of these enhancements, coupled with the limited electron response observed from CH47 on the previous rotation, flux levels are expected to only rise to be generally Moderate, with a chance of peaking diurnally at High.

With only a limited flux response anticipated from either fast wind enhancement, the associated 24hr fluence is expected to remain below the Active (1e8 integrated pfu) level. A slight, and increasing chance is maintained however, as there will be a potential for fluence to increase as solar winds ease later in the period. REFM, whilst currently giving a noisy signal, supports fluence levels remaining below the Active period, and is considered to be giving good guidance at this stage despite not taking account of the potential fast wind arrival.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	5	10	20
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 7: GOES-16 >2MeV Electron Fluence with REFM



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